ICES 1995

C.M. 1995/J:18
Baltic Fish Committee

POLISH HYDROACOUSTIC ASSESSMENT SURVEY OF HERRING, SPRAT AND COD STOCKS IN ICES SUBDIVISIONS 25 AND 26 OF THE BALTIC CONDUCTED IN OCTOBER 1994

by

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Abstract

Within an international program of the Baltic clupeoid fish assessment coordinated by the ICES Planning Group, the Polish research vessel "Baltica" carried out a hydroacoustic survey, devoted to herring and sprat in the ICES Subdivisions 25 and 26.

The survey covered the area of 14774 NM^2. Echosignals were integrated over 1204 one mile distances. Twenty nine control hauls with pelagic herring trawl were conducted. 9263 specimens of herring, 4612 of sprat and 73 of cod were measured. Otoliths from 1459 herring, 709 sprat and 73 cod for ageing were collected.

The estimated biomass density expressed in tonnes per 1 NM^2 equalled 30.1 tonnes for herring, 44.2 tonnes for sprat and 3.7 tonnes for cod. The results compared to data from October 1990 survey conducted from on board r.v. "Profesor Siedlecki", (Orłowski 1993) indicate a slight increase of the herring biomass density (by 1.9 tonnes), a significant increase of the sprat biomass density (by 26.7 tonnes) and also a large increase of the cod biomass density (by 2.3 tonnes). Distribution of the herring and sprat biomass has also exhibited some changes. Herring was less numerous in the Słupsk Furrow but was present in greater numbers in the Bornholm Deep. October sprat aggregations shifted northeastward. Cod caught with pelagic trawl appeared only in trace quantities in the Gdańsk Deep area.

The estimated herring and sprat biomass was recalculated into numbers at age using age-length key and mean weights for each ICES rectangle.

Introduction

During 3 - 20 of October 1994 r.v. "Baltica" carried out its maiden hydroacoustic cruise. The survey was a part of an international program of the Baltic clupeoid fish assessment prepared by the ICES Planning Group for Hydroacoustic Surveys in the Baltic (Anon. 1994). The main task of the cruise was assessment of herring and sprat stocks in terms of biomass and numbers in the ICES Subdivisions 25 and 26. The r.v."Baltica" survey continued the series of r.v. "Profesor Siedlecki" hydroacoustic surveys conducted during 1982-1990.

Equipment and survey method

Echosounding and echointegration were conducted during day and night continuously, using hydroacoustic system consisted of echosounder EK400, echointegrator QD and a PC. Echointegrator values referring to time periods equivalent to 1 NM distances covered by the vessel along the acoustic transect were recorded both as echodeflection and volume backscattering strength by recommended depth layers. The data together with mean depth of integrated layers were transferred from QD to PC and recorded on the hard disc. The vessel speed during echointegration was maintained within 8-10 knots depending on the sea state and wind speed.

The hydroacoustic system was calibrated using a standard copper sphere. The calibration was carried out next to the Swedish Island of Högön in the vicinity of Västervik harbour with assistance of dr Hakansson from Institute of Marine Research in Lysekil.

Control fishing

Control hauls were conducted only during daytime using midwater herring trawl WP 53/64 provided with 11 mm mesh bar length in the codend. Vertical opening of the trawl equalled 17-36 m (mean 26 m). Trawling speed was maintained at 3.5 knots. Standard trawling time of 30 minutes was followed. Two hauls per unit of survey area (ICES rectangle) was planned as a minimum required sampling density.

Area stratification and estimation of fish abundance in number

In accordance with the ICES Planning Group recommendations all survey results were recorded by ICES statistical rectangles. The parallel transect design was used, with equidistant spacing of approximately 15 NM, similar to that followed during the r.v.

"Profesor Siedlecki" cruises since 1982.

Fish abundance in numbers was calculated based on a total biomass estimate and mean individual weight of fish. The total biomass was estimated using Orłowski's method (1993). Target strength of 1 kg of herring and sprat was calculated applying the following formula:

$$TS_{kg} = 10 \text{ LOG } (l^2/w) - 41.2$$

where:

l - mean length in a rectangle (cm)

w - mean weight in a rectangle (grams)

The results of the calculations has been collated in the standard format recommended by the ICES Planning Group (Anon. 1994) and forwarded to the Group Chairman.

Results

The survey track along which the echo was integrated and positions of the control hauls are presented in Fig. 1. The area of rectangles included in the echointegration amounted to 14774 NM^2. Length of the vessel track covered with echointegration totalled 1365 NM but only 1204 NM were accepted for final analysis as elementary sampling distance units (ESDU).

In total 29 hauls were carried out of which 3 were rejected as not representative (Table 1). The index of rectangles coverage with control hauls equalled 1.7 (less than planned index of 2). The index of area coverage with representative acoustic transects amounted to 12.3 NM^2 per 1 ESDU (in 1990 - 9.26 NM^2).

The greatest biomass of 653,522 tonnes constituted sprat (Tab. 2, Fig. 2 and 3 - created using SURFER Golden Software Inc.), one third of which was concentrated in rectangles 4064 and 4065. Herring biomass was estimated at 444,284 tonnes. Near half of its biomass was confined to 3 rectangles in the northern part of the survey area. Cod biomass was estimated at 54,579 tonnes; almost all of it was found to be distributed in the Bornholm Deep.

The total length of sprat caught (Fig.4) varied within the range from 6.5 cm to 16.5 cm. The Subdivision 25 apart from rectangles 3760 and 4062 was dominated by sprat of 12,5 - 15.0 cm in length. In the two latter rectangles sprat of 7 - 9 cm were predominant while within the remaining rectangles sprat belonging to those length-classes were not numerous. The Subdivision 26 was dominated by sprat of 11 - 14 cm.

Examination of the sprat age distribution (Fig. 5) also indicates differences between Subdivisions 25 and 26. In the

Subdivision 25 mainly sprat from age groups 2 - 4 were taken except for rectangles 3760 and 4062 where sprat of the age group 0 were prevailing. In the Subdivision 26 younger (age groups 1 - 3) sprat were caught. Only in one rectangle (3764) a greater share of juvenile sprat (40% constituted age group 0) was found.

The total length of herring taken (Fig. 6 and 7) ranged from 7.5 cm to 29.0 cm. Fish from 16.5 cm to 22.5 cm in length were predominant. A considerable number of juvenile herring from length classes 8 - 12 cm was found in rectangles 3760 and 3764. Results of age readings (Fig. 8 and 9) indicated that they were herring from 1994 year-class (age group 0). Catches in the remaining rectangles were dominated by 3, 4 and 5 years old herring. An exception was age distribution in the rectangle 3863 where also age group 1 was quite abundant.

The estimated biomass of herring and sprat has been converted into numbers by successive age groups (Tab. 3 and 5). For each rectangle age-length keys and mean weights by age-groups were calculated (Tab. 4 and 5). That kind of presentation of the Baltic fish biomass hydroacoustic assessment survey results has been prepared in the SFI (Gdynia) for the first time.

In 1994, the percentage share of herring, sprat and cod in catches changed compared to 1990 (Fig. 10). A nearly stable distribution of the herring share in control hauls observed in 1990, changed towards a considerable increase of the herring proportion within rectangles of the Subdivision 25. In case of sprat an opposite trend took place i.e. their share has increased within rectangles of the Subdivision 26. On the other hand, cod taken in the pelagic layers of the Subdivision 25 occurred in a greater share than during 1990 survey.

Following the change of the percentage share of herring, sprat and cod in catches from control hauls conducted in 1994, the pattern of biomass distribution in the Polish EEZ has also changed (Fig. 11). Compared to 1990, the sprat biomass in the Subdivisions 26 and 25 increased considerably. Large quantities of herring appeared in rectangles 4060, 4061 and 4062 outside of the Polish zone. However, within the zone the herring biomass dropped by about 6,500 tonnes, mainly within the central part of the zone. A considerable increase of the cod biomass was noted in the western part of the EEZ. An insignificant quantity of cod biomass occured in the Gdańsk Deep (rectangle 3863).

In the Polish EEZ changes were also observed in the biomass distribution with regard to north-south (N-S) and west-east (W-E) direction (Fig. 12). The biomass distribution in the direction N-S was analysed by summing up the estimated fish biomass, originated from rectangles having identical two initial numbers in the rectangle code. The distribution in the W-E direction was estimated taking into account two last numbers in the code. Compared to 1990, the presence of herring was much more distinctly marked in the western part of the surveyed area (e.g. rectangles 3760, 3860, 3960, 4060 - were conventionally depicted by **60) and to a lesser extent in the eastern part (rectangles **63, **64). With regard to N-S distribution a considerable increase of the herring biomass in the southern part (**38) was noted. Sprat biomass shifted northward (rectangle 39**) and eastward (**62, **63). Cod shifted to a large extent to the southern part of N-S direction and to the western part of the W-E direction.

Acknowledgments

Authors extend their thanks to dr N. Hakansson from the Swedish Institute of Marine Research in Lysekil for consultations as well for his participation in the calibration of the r/v "Baltica" acoustic system, and to dr A. Orłowski from SFI in Gdynia for his advice on the biomass calculation method.

Summary

During 3 - 20 of October 1994 r.v. "Baltica" carried out its maiden hydroacoustic survey. The investigations were part of an international program of the Baltic clupeoid fish assessment prepared by the ICES Planning Group for Hydroacoustic Surveys. The main task of the cruise was assessment of herring and sprat stocks in terms of biomass and numbers in the ICES Subdivisions 25 and 26 (the southern Baltic).

The r.v."Baltica" survey continued the series of r.v. "Profesor Siedlecki" hydroacoustic cruises conducted during 1982-1990.

The survey covered the area of 14774 NM^2. Echosignals were integrated over 1204 one mile distances (ESDU). Twenty nine control hauls with midwater trawl were conducted. 9263 specimens of herring, 4612 of sprat and 73 of cod were measured. Otoliths from 1459 herring, 709 sprat and 73 cod were collected for ageing.

An insignificant increase of the herring biomass density from the level of 28.2 t/NM^2 in 1990 to the level of 30.1 t/NM^2 in 1994 was noted; moreover a considerable increase of the sprat biomass density from 17.5 t/NM^2 to 44.2 t/NM^2 as well as also marked augmentation of the cod biomass from 1.5 to 3.7 t/NM^2, respectively, was observed.

Certain changes in the distribution of herring and sprat biomass compared to 1990 in the Polish EEZ has also occured. Relatively smaller quantities of herring were found in the Słupsk Furrow and greater in the southern part of the Bornholm

Deep. The October 1994 aggregations of sprat shifted northeastward. Pelagic biomass of cod moved to the western part of the W-E direction and to the southern part of the N-S direction.

Catches from control hauls conducted in the Subdivision 25 were dominated with sprat of age groups 2 - 4 while in the Subdivision 26 predominated fish by one year younger. The juvenile sprat occurred in trace quantities in almost all rectangles of both Subdivisions but the southern part of the Bornholm Deep, Gulf of Gdańsk and the southern part of Middle Bank where they prevailed. In the above mentioned areas juvenile herring was also present whereas in the remaining rectangles 3, 4 and 5 years old herring dominated the control catches.

The estimated biomass of herring and sprat has been converted into numbers by succesive age groups. For each rectangle age-length keys and mean weights by age-groups were calculated. That kind of presentation of the Baltic fish biomass hydroacoustic assessment survey results has been prepared in the SFI for the first time.

References

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Table 1. Catch data

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

No. of haul	Date	Time start UTC	Latitude start DD	MM	Longitude start DD	MM	Duration min.	Speed kn	Water depth m	Headrop depth m	Net opening m	Validity	Total catch kg/h
1	94-10-05	07:50	55	22.9	15	20	00:50	3.5	91		0	invalid	0
2	94-10-05	16:00	55	21.1	15	27.3	00:30	3.5	93	43	17		50.7
3	94-10-06	07:30	55	32.7	15	52.8	00:30	3.5	80	46	26		101.6
4	94-10-09	09:00	55	35.6	15	56.1	00:30	3.6	78	40	26		155.3
5	94-10-09	11:00	55	26	15	54.9	00:30	3.5	88	50	28		505.7
6	94-10-09	17:00	55	3.2	15	35.7	00:30	3.5	78	12	28		57.9
7	94-10-11	07:30	54	31.8	15	50.4	01:00	3.5	52	12	24		6.9
8	94-10-11	12:05	54	53.6	15	37.7	00:30	3.5	76	34	26		55.1
9	94-10-11	15:40	54	55.7	16	11.6	00:30	3.5	54		0	invalid	0
10	94-10-11	17:55	54	57.9	16	2.1	00:30	3.5	72		0	invalid	5.9
11	94-10-12	13:00	55	25.4	16	49.1	00:45	3.5	48	19	26		37.2
12	94-10-12	15:55	55	15	16	49.5	00:30	3.5	78	34	26		60.6
13	94-10-13	12:15	55	44.1	17	46.5	00:35	3.5	61	22	26		11
14	94-10-13	15:30	55	25.8	17	50.9	00:30	3.9	73	32	25		875.6
15	94-10-13	17:50	55	20.5	17	40.1	00:30	3.5	83	30	25		32.7
16	94-10-15	07:25	55	35.4	18	27.8	00:30		100	68	24		201.2
17	94-10-15	09:55	55	36.5	18	55.2	00:30	3.5	89	60	25		192
18	94-10-15	12:05	55	25.7	18	56.8	00:35	3.7	94	64	25		670.6
19	94-10-15	15:50	55	16.2	18	46.8	01:00	3.6	88	30	22		43.2
20	94-10-16	09:15	55	59.8	19	13.5	00:35	3.5	97	54	36		325.4
21	94-10-16	14:55	55	49.9	19	28.9	00:30	3.5	62	30	24		207.6
22	94-10-16	16:45	55	52.6	19	37.1	00:30	3.5	62	20	25		61.5
23	94-10-17	09:35	55	40.8	20	6.1	00:30	3.4	74	42	28		231.8
24	94-10-18	15:55	54	29.8	18	54.8	00:30	3.7	62	25	24		79.5
25	94-10-19	07:10	54	55	18	49.7	00:30	3.4	97	57	28		54.7
26	94-10-19	09:50	55	2.5	19	11.6	00:30	3.5	103	55	28		151.6
27	94-10-19	13:10	54	45.3	19	22.3	01:00	3.9	101	41	26		334.5
28	94-10-19	15:15	54	35.7	19	23.8	00:35	3.5	78	45	25		661.7
29	94-10-19	07:05	54	29.4	19	33	00:30	3.6	48	18	26		14.9

Table 2. Fish density and biomass estimates by ICES squares

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

ICES rect-angle	Area [NM^2]	< I > [mm]	<Svc> [dB]	Biomass area density [t/NM^2] Herring	Sprat	Cod	Biomass [t] Herring	Sprat	Cod
3760	685.0	62.40	-46.58	6.25	25.89	25.02	4279.4	17736.3	17141.2
3764	162.7	69.23	-46.14	1.89	71.25	0.00	307.0	11592.7	0.0
3860	1043.8	40.39	-48.47	41.36	8.70	12.19	43167.0	9076.5	12727.9
3863	706.4	78.15	-45.61	40.42	51.37	1.03	28555.4	36285.1	726.1
3864	946.1	59.37	-46.80	52.86	36.36	0.30	50011.2	34402.3	288.0
3960	985.0	23.75	-50.78	18.47	17.37	2.55	18190.4	17112.5	2511.1
3961	1032.2	39.81	-48.54	23.77	36.13	1.51	24538.4	37292.5	1559.4
3962	1032.2	48.36	-47.69	17.77	51.56	0.00	18341.2	53220.3	0.0
3963	1032.2	44.84	-48.02	3.85	54.36	0.00	3978.1	56114.3	0.0
3964	1032.2	74.38	-45.82	9.50	86.69	0.00	9802.7	89485.7	0.0
4060	1019.3	56.44	-47.02	59.08	18.16	13.16	60221.5	18513.4	13417.4
4061	1019.3	50.54	-47.50	65.59	16.21	6.09	66851.5	16518.0	6207.7
4062	1019.3	11.18	-54.05	19.93	0.95	0.00	20318.7	964.1	0.0
4063	1019.3	46.60	-47.85	21.37	41.33	0.00	21780.2	42132.2	0.0
4064	1019.3	107.75	-44.21	72.24	81.98	0.00	73630.8	83560.5	0.0
4065	1019.3	102.24	-44.44	0.31	127.06	0.00	310.9	129515.3	0.0
	14773.6			30.07	44.24	3.69	444284	653522	54579

Table 3. Estimated number (in millions) of herring

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

SD	Strata	Total	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
25	3760	420	391	6	0	0	6	6	0	6	6	0	0
	3860	927	25	167	106	259	221	133	4	12	0	0	0
	3960	353	7	58	29	89	109	49	2	7	0	0	0
	3961	584	77	19	42	192	171	44	29	9	1	1	0
	3962	512	48	4	35	100	176	114	25	6	3	1	1
	4060	1180	11	103	107	228	284	293	68	66	15	2	0
	4061	1559	201	48	143	483	458	109	86	22	3	3	0
	4062	456	7	29	73	91	111	63	35	21	12	10	3
26	3764	27	21	5	0	0	2	0	0	0	0	0	0
	3863	1334	152	386	180	331	109	108	23	20	16	9	0
	3864	1225	33	126	162	207	260	290	127	2	17	0	0
	3963	116	0	9	14	34	42	14	2	1	0	0	0
	3964	238	2	12	28	66	76	27	14	6	6	0	0
	4063	585	1	40	85	223	150	32	26	16	4	7	1
	4064	1998	0	24	72	453	753	370	134	112	72	4	0
	4065	7	0	3	0	2	0	0	1	0	0	0	0

Table 4. Estimated mean weight (in gramms) of herring

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

SD	Strata	Total	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
25	3760	10.2	7.6	5.5	0.0	0.0	70.0	40.0	0.0	75.0	40.0	0.0	0.0
	3860	46.6	20.9	39.0	49.6	49.1	48.6	46.6	112.5	66.7	0.0	0.0	0.0
	3960	51.5	19.3	39.6	49.1	53.7	54.7	56.5	80.6	56.8	0.0	0.0	0.0
	3961	42.0	6.3	38.2	41.7	45.7	46.7	53.4	57.5	76.7	83.8	80.0	0.0
	3962	35.8	5.6	20.4	33.2	38.9	37.2	40.2	45.1	66.6	65.2	105.0	68.8
	4060	51.0	5.1	39.0	39.1	48.6	50.8	56.4	61.6	61.6	76.8	112.8	0.0
	4061	42.9	6.2	34.4	40.5	45.6	47.7	57.1	64.1	82.1	121.0	98.3	0.0
	4062	44.6	5.0	24.9	31.5	37.3	41.3	50.8	56.8	77.6	83.1	107.8	97.5
26	3764	11.3	5.9	27.5	0.0	0.0	32.5	0.0	0.0	0.0	0.0	0.0	0.0
	3863	21.4	5.7	12.7	20.5	24.3	31.9	27.3	73.4	64.9	66.2	68.8	0.0
	3864	40.8	6.4	23.3	35.0	44.2	44.0	46.5	44.1	77.7	76.1	0.0	0.0
	3963	34.2	0.0	34.3	29.6	32.9	31.0	43.0	64.3	80.5	83.8	0.0	0.0
	3964	41.2	10.3	35.8	36.3	39.7	37.2	44.3	53.8	76.5	68.2	0.0	115.0
	4063	37.2	10.0	25.1	30.5	34.2	34.6	55.8	55.2	72.0	101.6	75.8	90.0
	4064	36.9	0.0	20.7	29.3	34.8	31.3	40.6	42.3	57.3	55.4	111.7	0.0
	4065	47.5	0.0	36.7	0.0	40.0	0.0	0.0	95.0	0.0	0.0	0.0	0.0

Table 5. Estimated number (in millions) of sprat

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

SD	Strata	Total	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
25	3760	4295	4088	69	90	47	0	0	0	0	0
	3860	663	204	25	145	159	92	27	2	11	0
	3960	1211	315	40	285	344	138	52	21	15	2
	3961	2394	156	7	318	807	594	280	211	19	0
	3962	3698	0	126	828	1513	754	215	122	0	0
	4060	1051	68	28	188	306	251	203	5	0	0
	4061	988	48	0	112	288	296	161	78	4	0
	4062	213	180	0	0	7	7	10	7	3	0
26	3764	1803	790	435	380	162	16	13	0	7	0
	3863	3136	72	834	1251	646	210	44	34	0	44
	3864	3433	137	1243	1284	697	45	17	10	0	0
	3963	4185	100	126	1670	1682	360	234	13	0	0
	3964	7228	36	1077	3448	1944	405	296	22	0	0
	4063	3459	62	138	1785	854	367	111	142	0	0
	4064	7124	78	2137	3733	1026	93	21	21	0	0
	4065	11533	0	5213	4809	1107	265	138	0	0	0

Table 6. Estimated mean weight (in gramms) of sprat

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

SD	Strata	Total	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
25	3760	4.1	3.6	11.7	16.3	15.0	0.0	0.0	0.0	0.0	0.0
	3860	13.7	4.2	13.9	16.8	18.1	19.1	20.2	21.7	20.8	0.0
	3960	14.1	4.0	13.3	16.6	17.9	19.1	19.9	19.8	21.0	21.5
	3961	15.6	4.5	10.0	14.5	15.4	17.2	19.6	15.8	20.0	0.0
	3962	14.4	0.0	12.6	13.2	15.0	15.9	18.2	16.4	0.0	0.0
	4060	17.6	4.0	12.2	15.6	17.7	18.4	19.7	21.8	0.0	0.0
	4061	16.7	4.5	0.0	15.6	16.2	18.1	19.5	16.6	20.7	0.0
	4062	4.5	2.5	0.0	0.0	12.5	16.7	17.2	15.0	15.0	0.0
26	3764	6.4	2.9	8.1	9.6	10.2	11.4	16.0	0.0	11.7	0.0
	3863	11.6	4.4	9.5	11.4	13.7	13.3	18.1	17.1	0.0	17.4
	3864	10.0	3.2	9.1	10.4	11.5	18.1	14.0	22.0	0.0	0.0
	3963	13.4	3.4	10.9	12.7	13.8	16.1	17.4	20.0	0.0	0.0
	3964	12.4	4.5	9.9	11.9	13.6	14.3	16.5	20.0	0.0	0.0
	4063	12.2	2.8	9.9	11.6	13.1	13.9	15.2	13.7	0.0	0.0
	4064	11.7	4.2	10.5	11.9	12.7	16.5	17.6	17.6	0.0	0.0
	4065	11.2	0.0	9.9	11.2	14.9	20.5	15.0	0.0	0.0	0.0

Fig. 1. Location of acoustic samples and control hauls

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

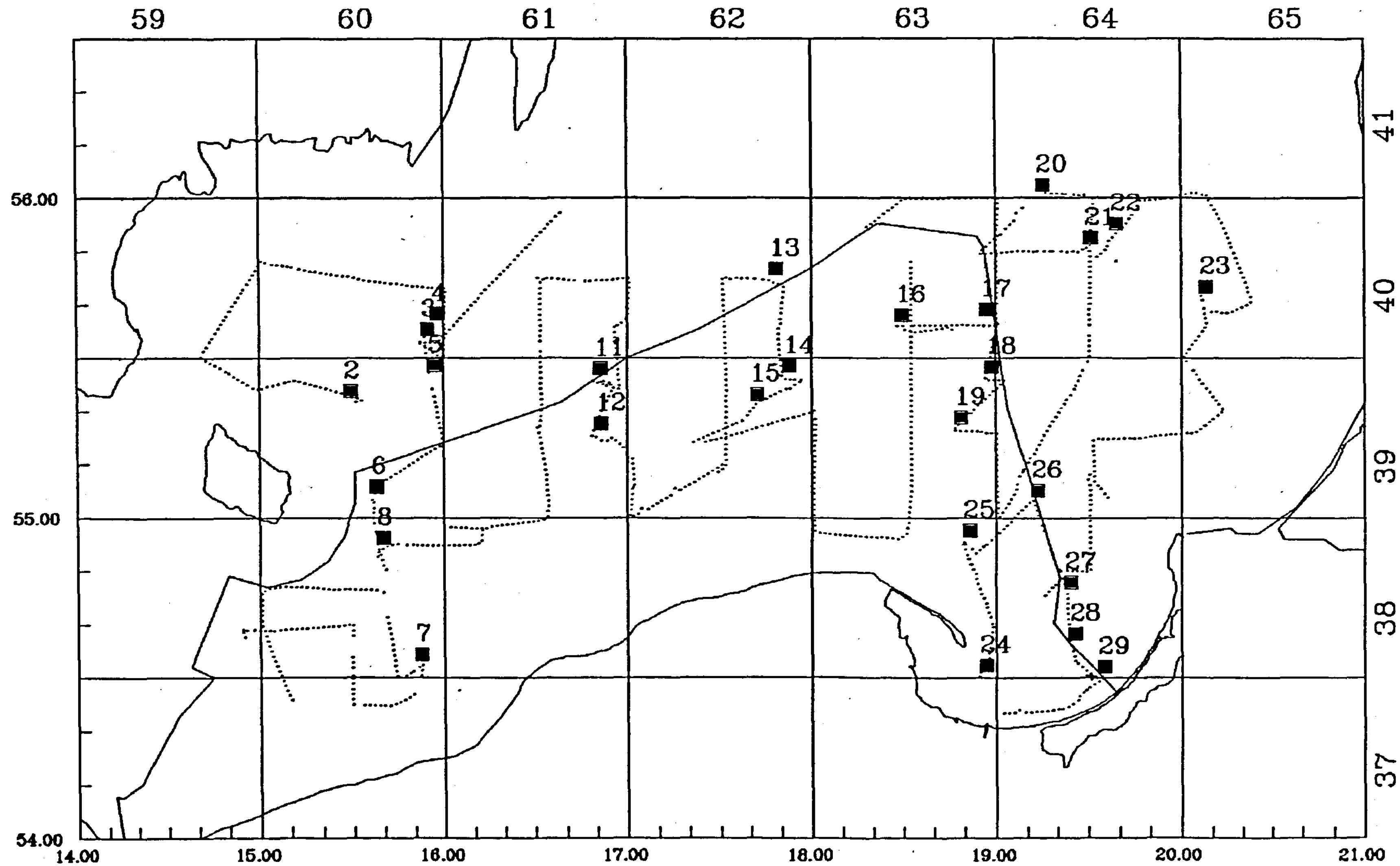


Fig. 2. Distribution of herring biomass (t/NM²)

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey

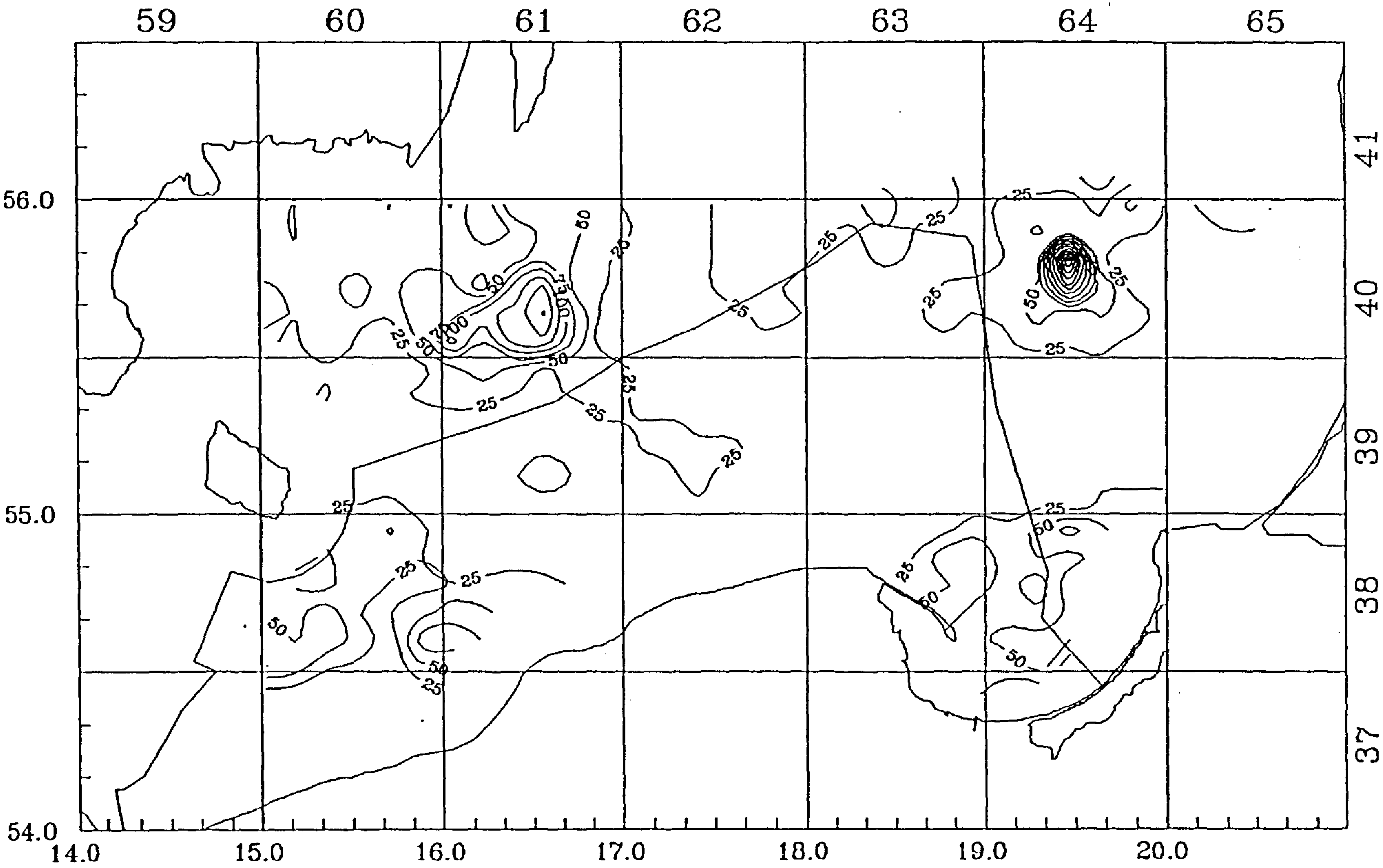
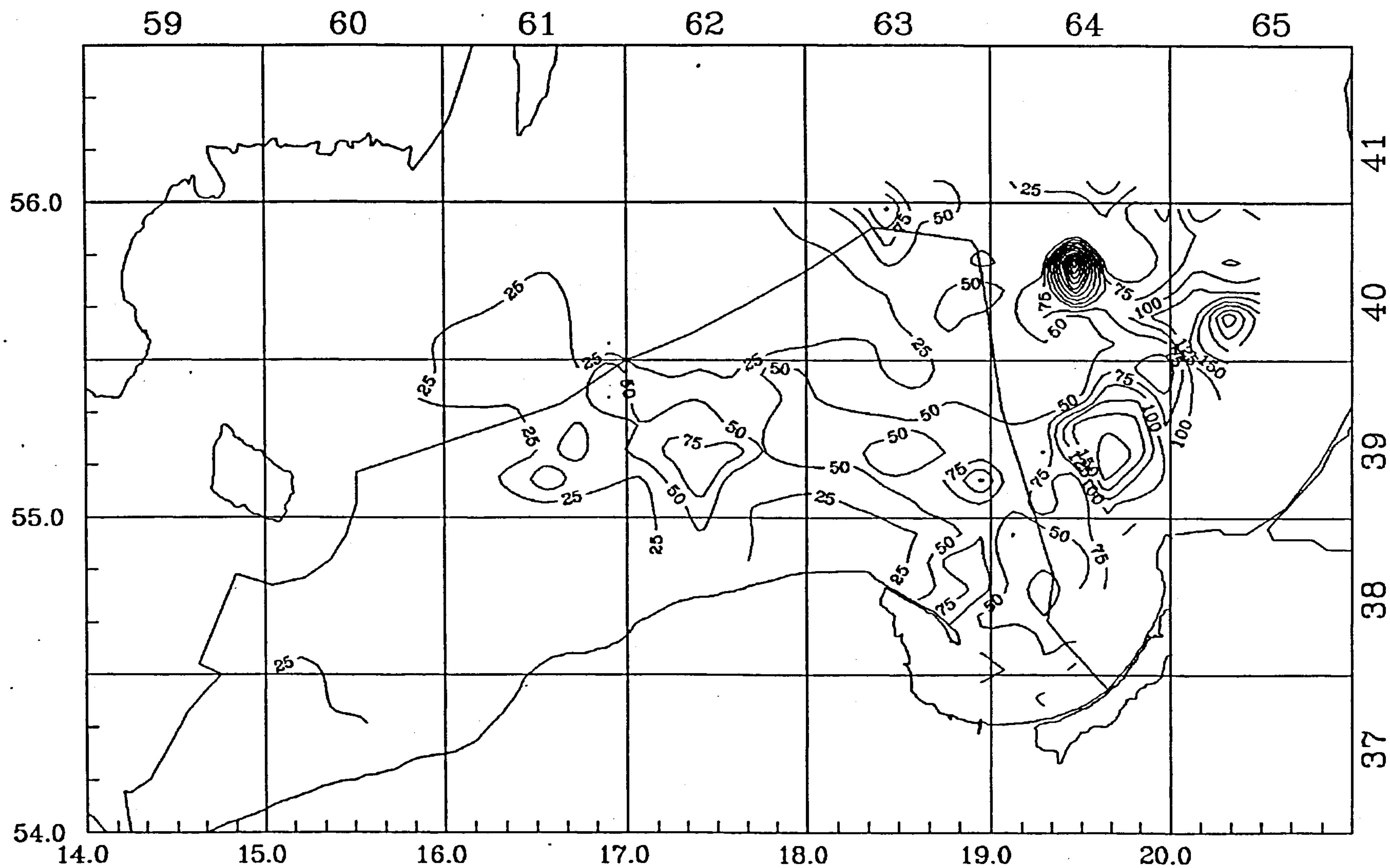


Fig. 3. Distribution of sprat biomass (t/NM^2)

r.v. "Baltica", 3-20.10.1994, hydroacoustic survey



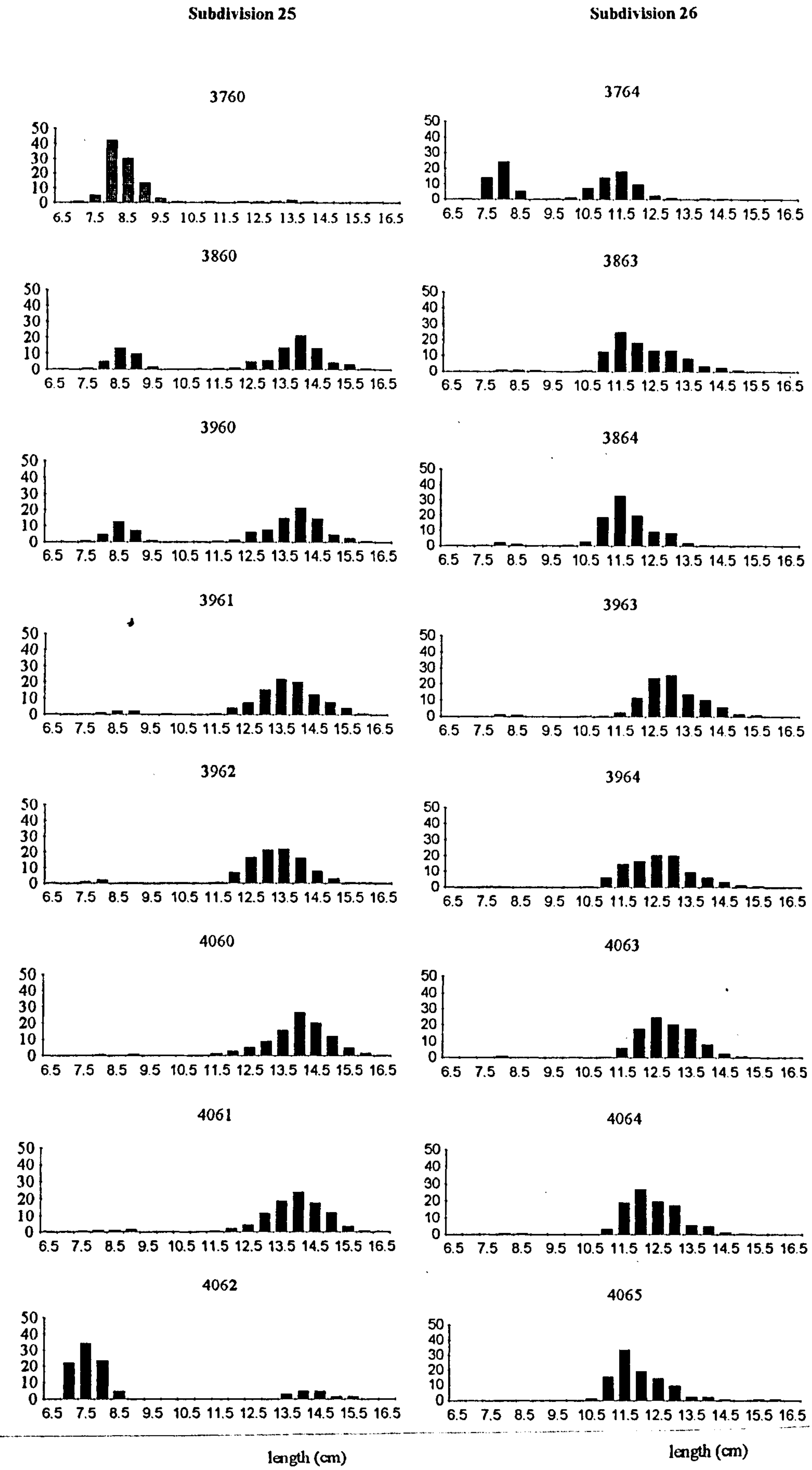


Fig. 4. Length distribution of sprat by rectangles

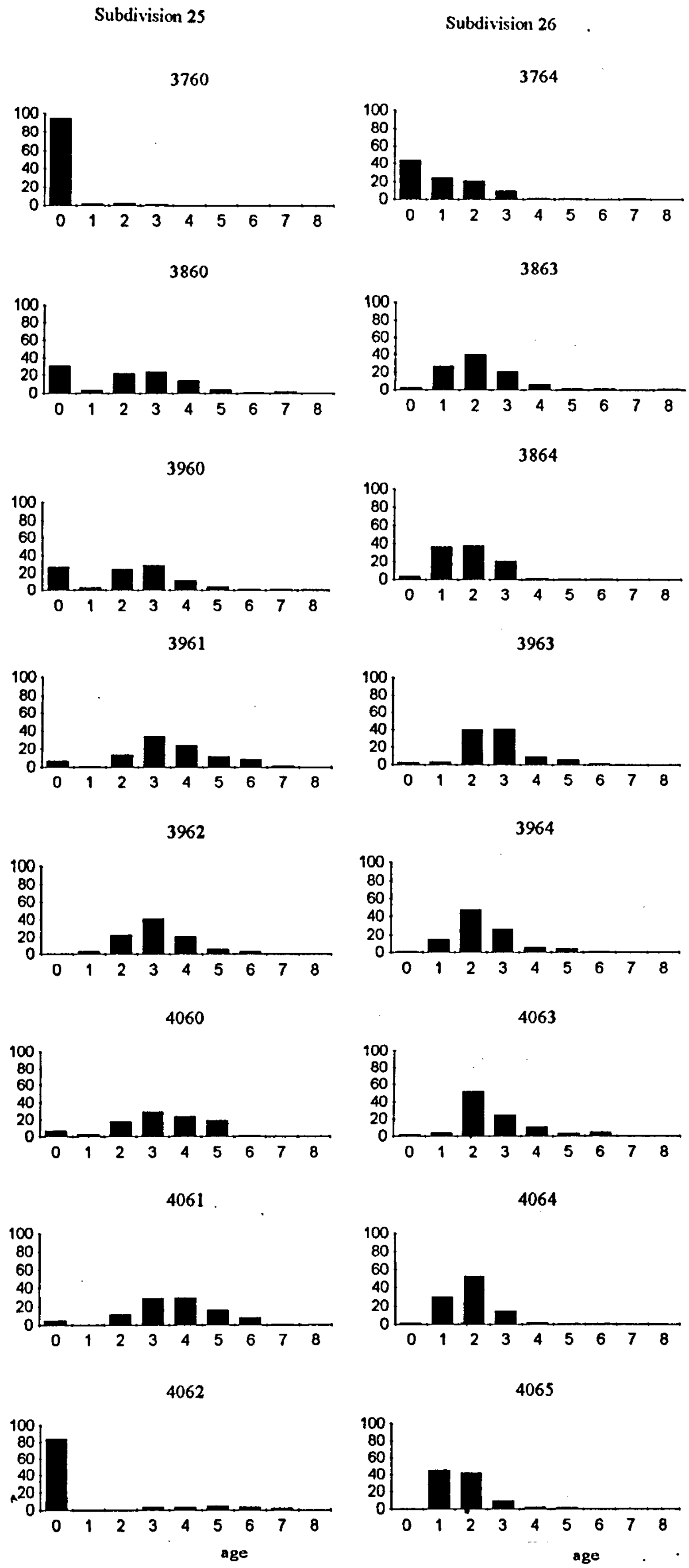


Fig. 5. Age distribution of sprat by rectangles

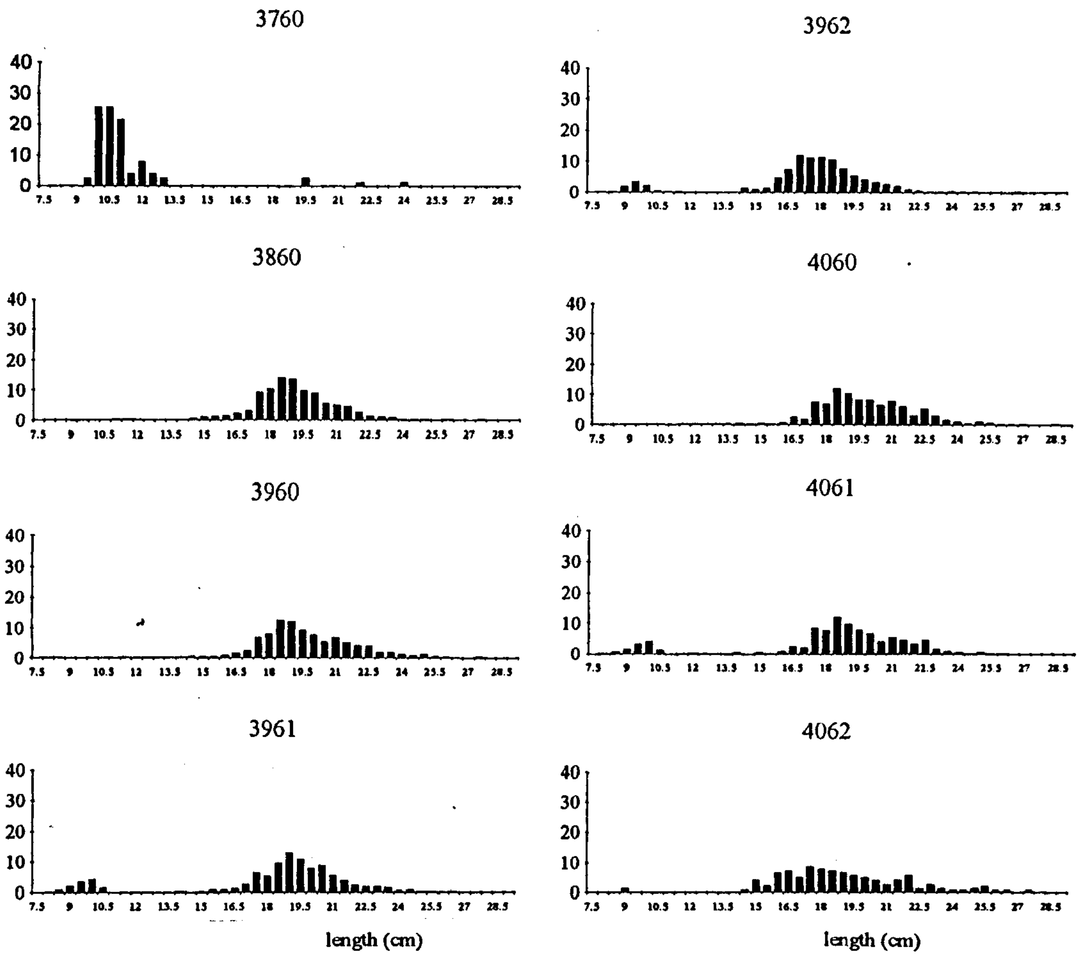


Fig. 6. Length distribution of herring by rectangles in Subdivision 25

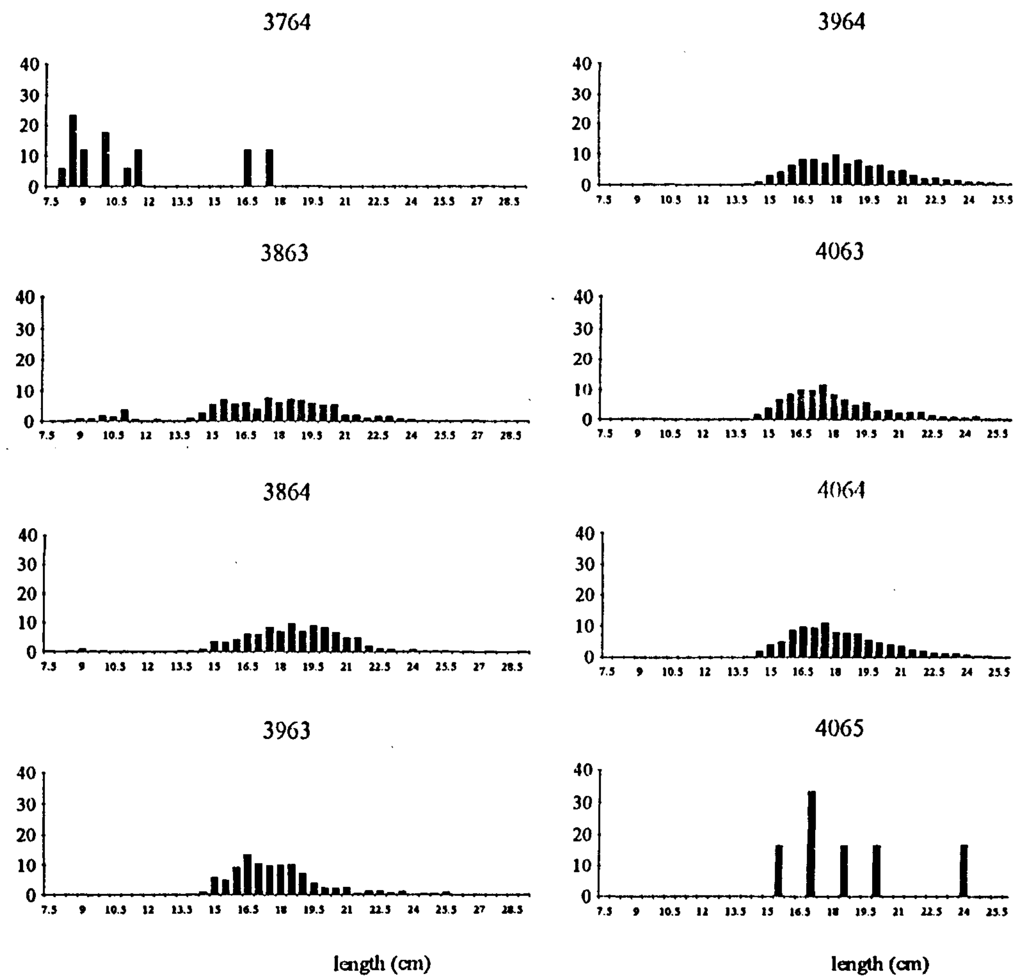


Fig. 7. Length distribution of herring by rectangles in Subdivision 26

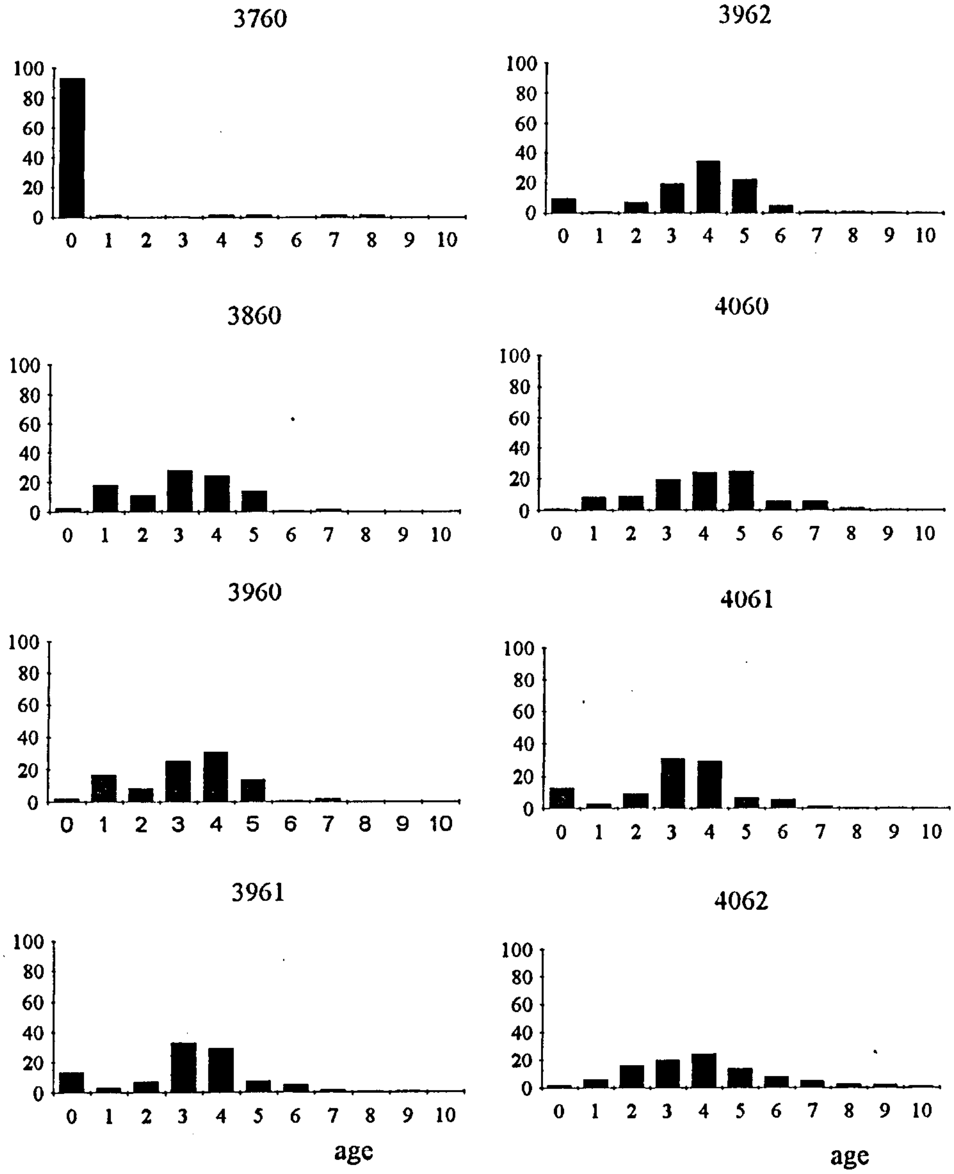


Fig. 8. Age distribution of herring by rectangles in Subdivision 25

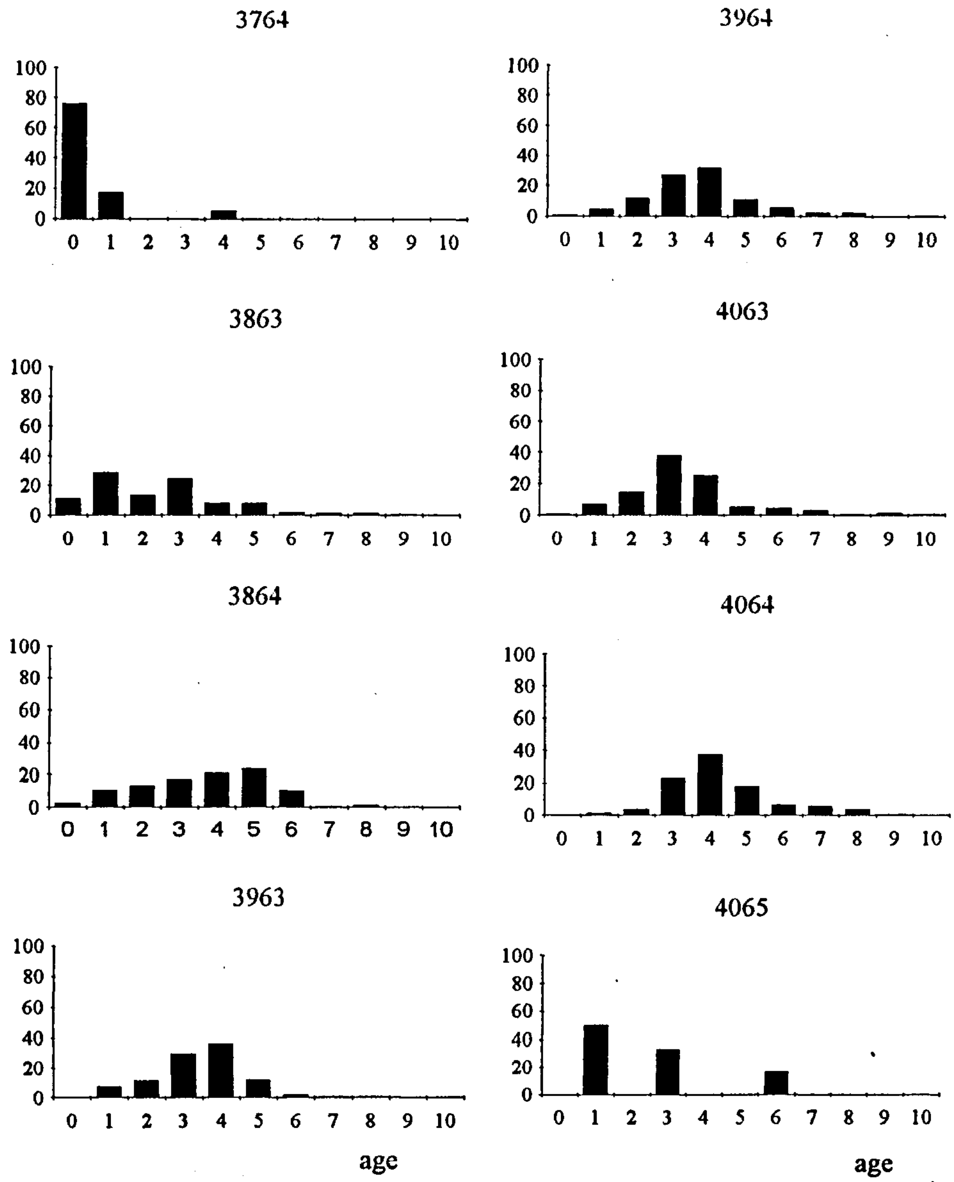


Fig. 9. Age distribution of herring by rectangles in Subdivision 26

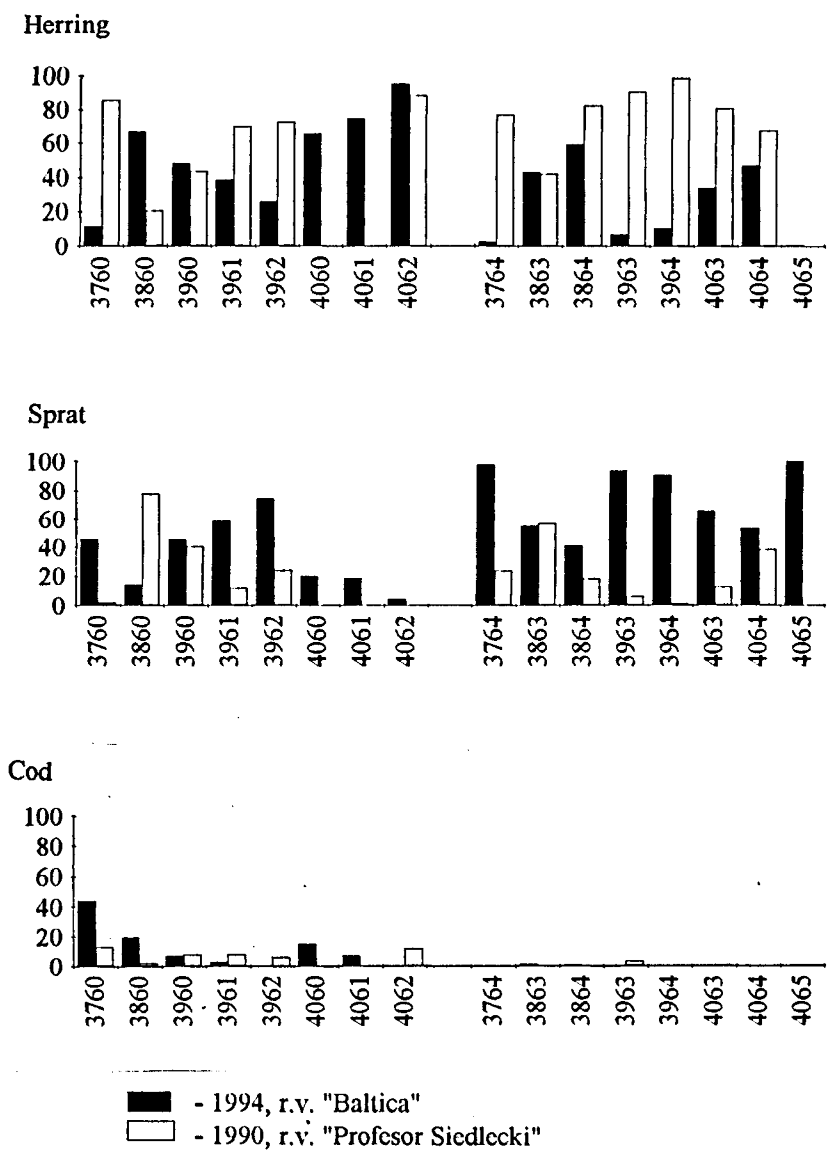


Fig. 10. Species compositon of control hauls in 1994
compared to that of 1990

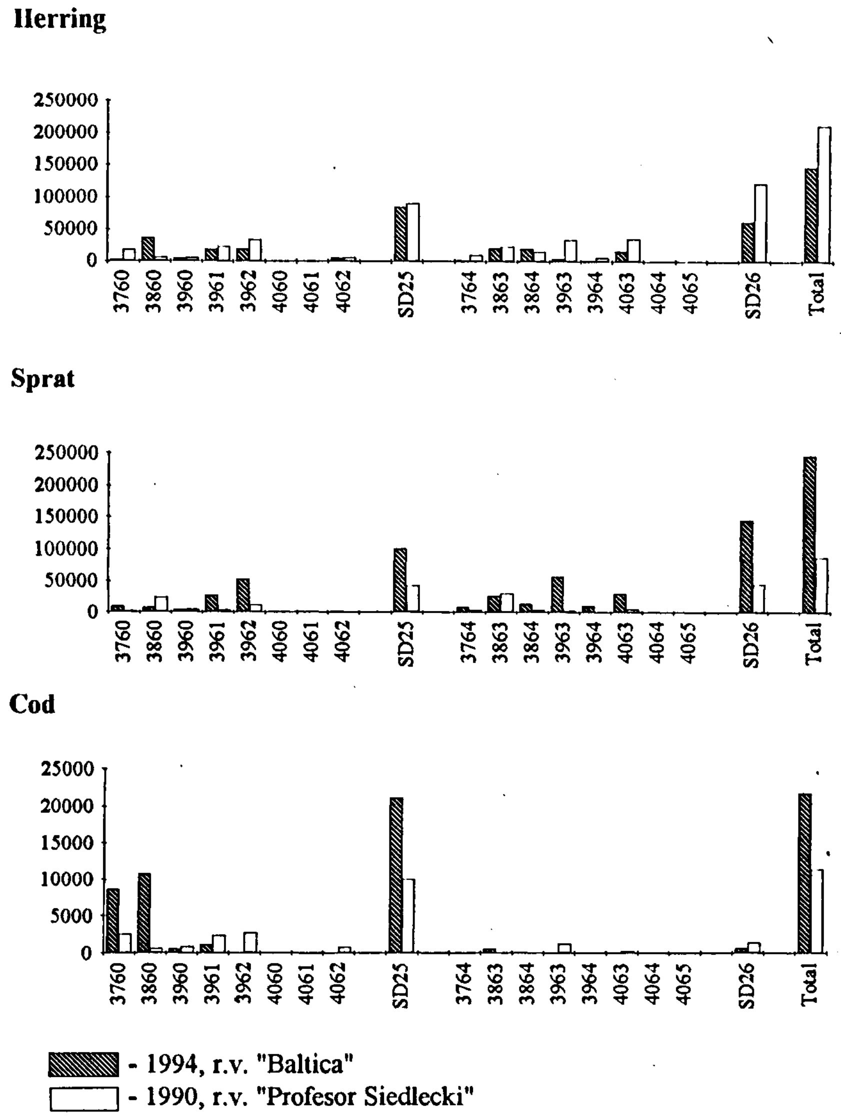


Fig. 11. Hydroacoustic estimates of herring, sprat and cod biomass (t) in the Polish EEZ by rectangles in 1994 compared to those of 1990

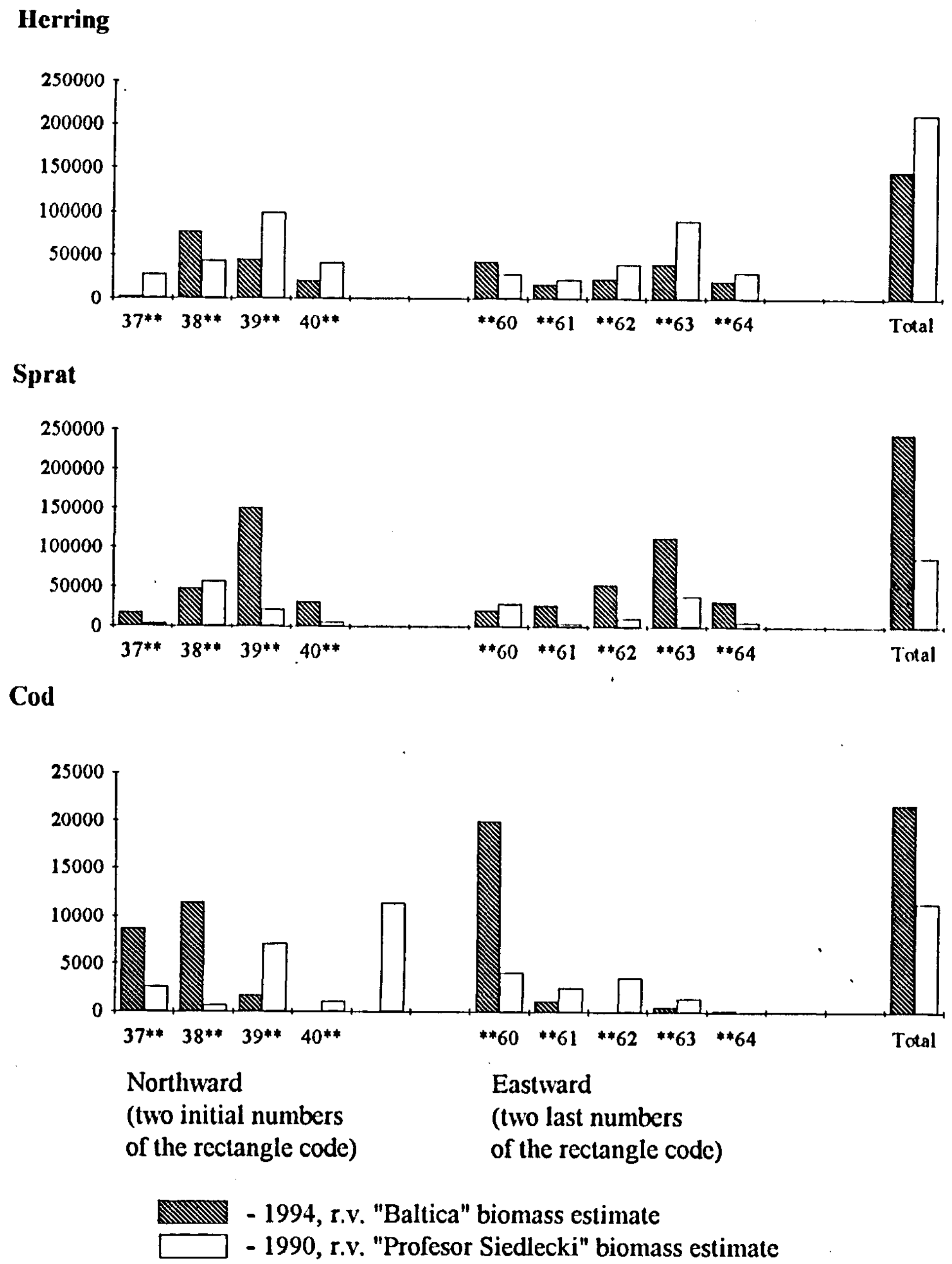


Fig. 12. Changes in the distribution of the herring, sprat and co biomass in the Polish EEZ in 1990 and 1994 in N-S and W-E directions